



An Energy Efficiency Workshop & Exposition

Kansas City, Missouri



***The Laboratories for the 21st Century
Partnership Program***

Unique Aspects of Energy Consumption in Labs



**Presented by Frank Kutlak, RA
Division of Engineering Services
National Institutes of Health**





Research Laboratories Design

- Research laboratories are energy demanding for a variety of reasons:
 - Safety requirement for once through air
 - Large numbers of containment and exhaust devices
 - Excessive amount of heat generating and power consuming equipment
 - Extensive telecommunications systems
 - 24 hour access requirement by Scientists
 - Irreplaceable experiments require fail safe redundant back up systems, and UPS or emergency power



June 3-6, 2001

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Air Handling Systems Multiple Air Handler Units

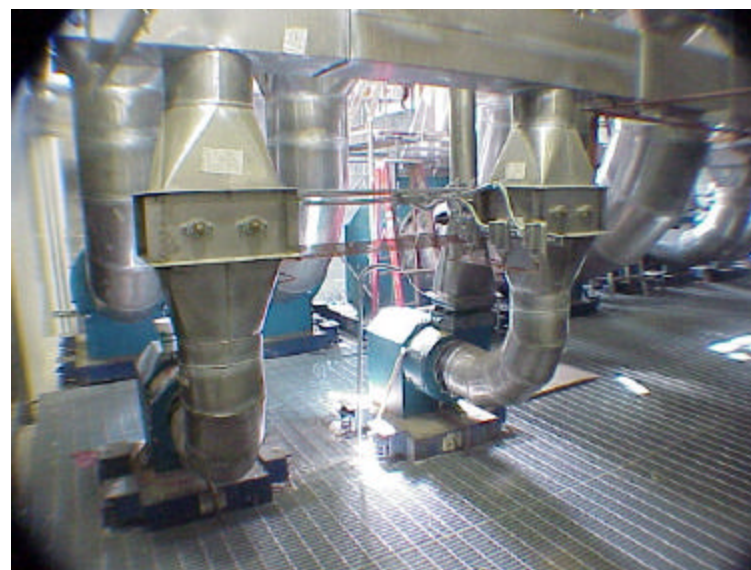


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Air Handling Systems Multiple Exhaust Fans



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Air Handling Systems Multiple Exhaust Systems Ductwork



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Air Handling Systems Exhaust Stacks

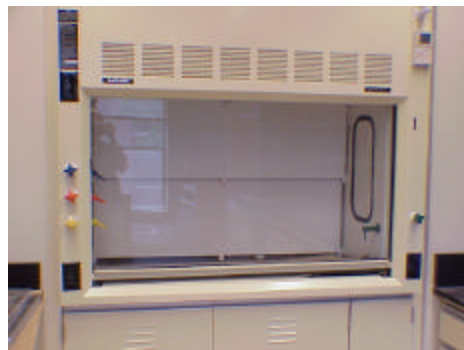


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Typical Research Laboratory Equipment Special Containment and Exhaust Devices



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Typical Research Laboratory Equipment Animal Holding Ventilated Cages Point Exhausts



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Typical Research Laboratory Equipment



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Typical Research Laboratory Equipment



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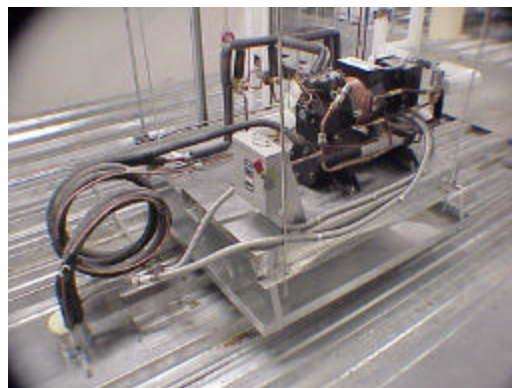
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Typical Research Laboratory Equipment





Typical Research Laboratory Equipment Cold Rooms and Autoclaves / Glass Wash Rooms

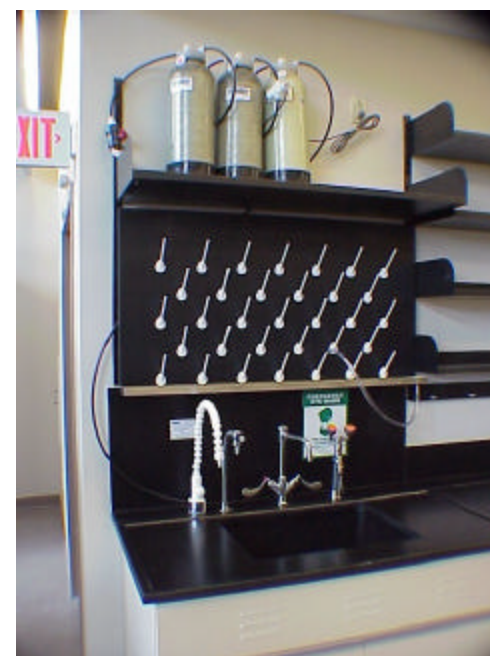


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Typical Research Laboratory Equipment Special Central Support Systems Reverse Osmosis and Filtered Water





Typical Research Laboratory Equipment Special Central Support Systems Vacuum & Compressed Air Systems



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Typical Research Laboratory Facility Special Central Support Systems Scientific Gases

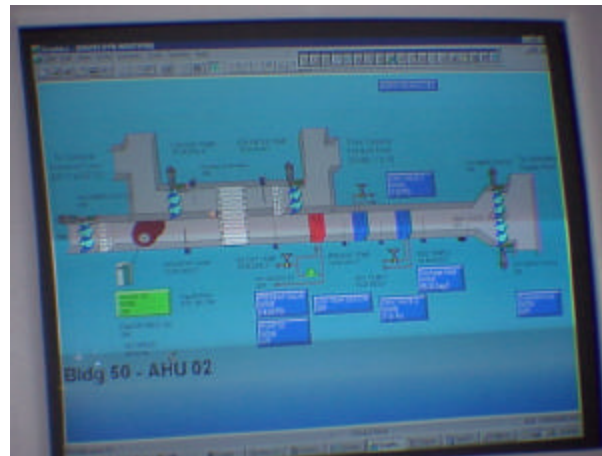


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Typical Research Laboratory Facility Special Central Support Systems Fire Protection & Building Automation



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Typical Research Laboratory Facility Special Central Support Systems Transformers and Switchgear



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Typical Research Laboratory Facility Special Central Support Systems Emergency & Uninterruptible (UPS) Power

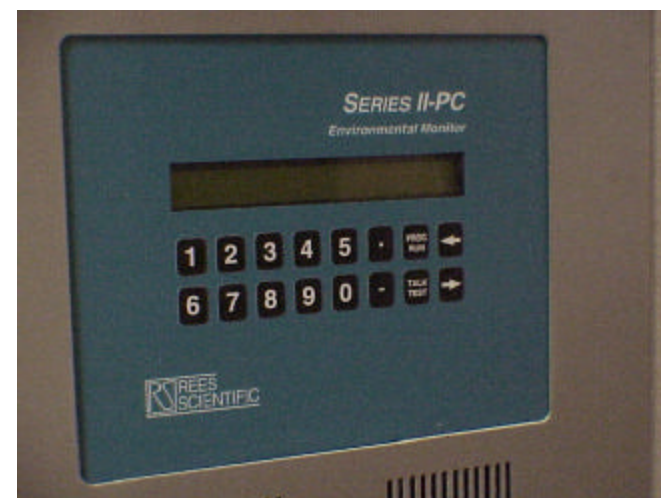


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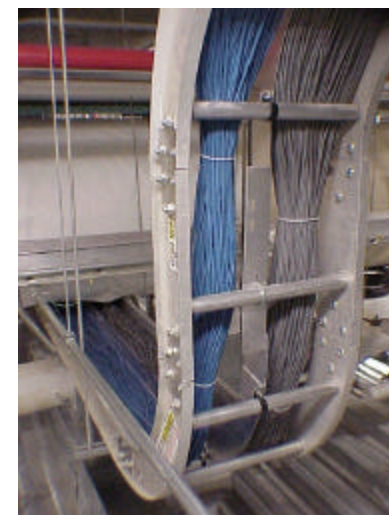
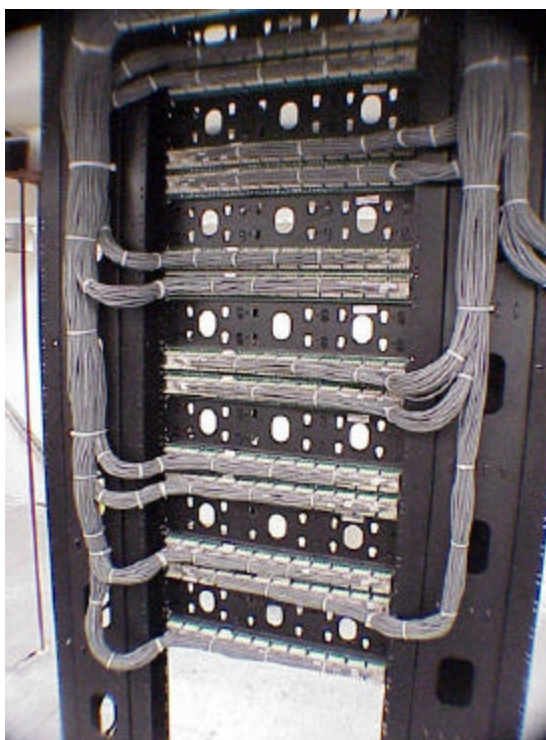
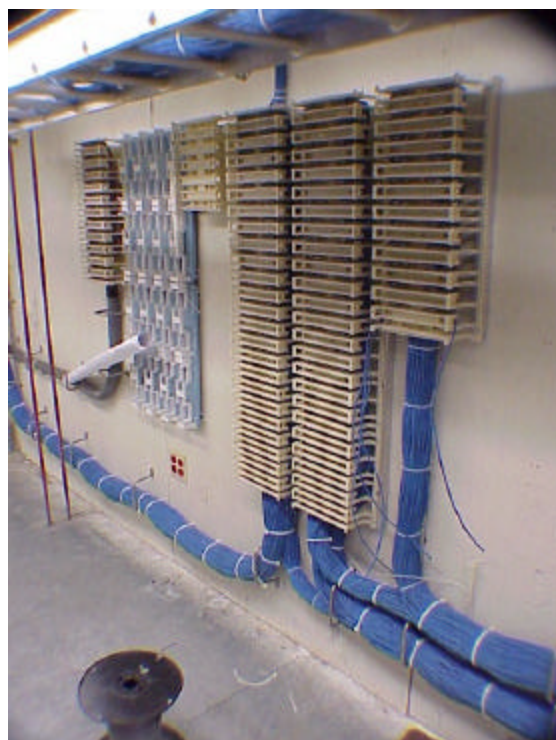
Typical Research Laboratory Equipment Telecomm, Access and Equipment Monitoring Systems



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Typical Research Laboratory Facility Telecommunications Systems Equipment



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Typical Research Laboratory Facility Special Central Support Systems – Steam Systems



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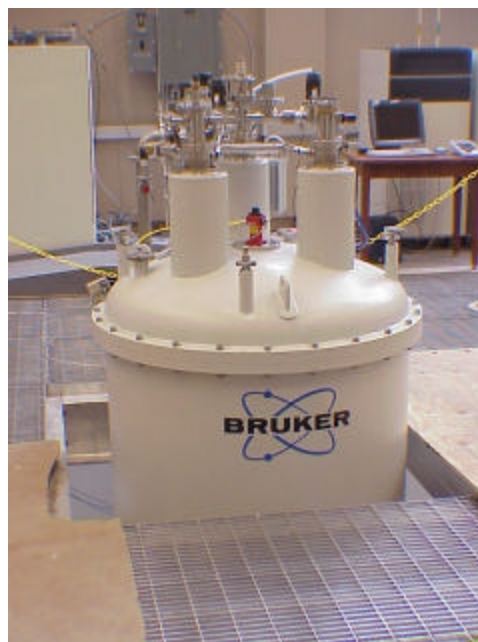
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Typical Research Laboratory Equipment Animal Holding Cagewash Facilities



Typical Research Laboratory Equipment Nuclear Magnetic Resonator NMR Suite



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Typical Research Laboratory Equipment Electron Microscope Suite





Energy Concerns in the Design of Research Labs

- **Comply with Executive Order 13123 - “Greening the Government Through Efficient Energy Management”** issued June 8, 1999 which requires the Federal Government to improve it’s energy management practices.
 - **Sec. 203 specifically requires that Laboratory Facilities reduce energy consumption by 20% by 2005 and 25% by 2010, relative to 1990**
- **Architectural**
- **Mechanical**
- **Electrical**





Executive Order 13123 - Greening the Government Through Efficient Energy Management, issued June 8, 1999



- This is a broad directive that requires the Federal Government to improve its energy management practices.
- Under “Part 2 Goals”, Energy Efficiency Improvement Goals - Sec. 203 is a specific section on “Industrial and Laboratory Facilities”
- Sec. 203 “***Industrial and Laboratory Facilities***, Through life cycle cost effective measures, each agency shall reduce energy consumption per square foot, per unit of production, or per other unit as applicable by **20 percent by 2005 and 25 percent by 2010 relative to 1990**. No facilities will be exempt from these goals unless they meet new criteria for exemptions, as issued by DOE”.

Architectural Concerns in the Design of Energy Efficient Research Labs

- Overall Concerns with Energy Issues in the Design of the Facility
- Maximum feasible and practical energy efficiency should be a prime design program requirement and one of the major goals of the design
 - square footage and budget must be assigned to energy efficient design features and the building design must accommodate them
- Building Layout, Mass and Orientation should enhance energy efficiency
- Elements of Enclosure / Exterior Skin should be energy efficient

**Waterproofing
and Flashing**



**2" Rigid
Insulation**





Electrical Concerns in the Design of Energy Efficient Research Labs

- **Power Design Levels and System configuration**
- **Lighting**



Bldg. 50 Electrical System Basis of Design



Main Transformer



Switchgear



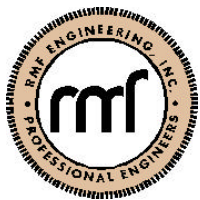
Cable Bus



**Transformer
in Interstitial**



Cable tray





Mechanical Concerns in the Design of Energy Efficient Research Labs

- The single largest energy consumer in Laboratories is the large amount of ventilation air required to maintain a safe environment, thus HVAC design concerns focus on this requirement.
- Building Supply and Exhaust Systems
 - Constant Volume or Variable Air Volume System
- Containment Devices (primarily fume hoods)
 - Constant Volume or Variable Air Volume Fume Hoods
- Use and Extent of Variable Frequency Drives
- Controls and Building Automation System
- Energy Recovery Systems
 - Decisions about extent and types of energy recovery



Bldg. 50 Mechanical System Basis of Design



VAV Exhaust Fans



VAV Terminal Box



Energy Wheel



Lab Piping



Utility Tunnel



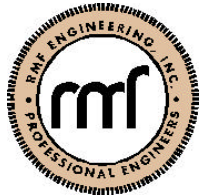
Basement Mech room



Utility Shafts



Mech Penthouse

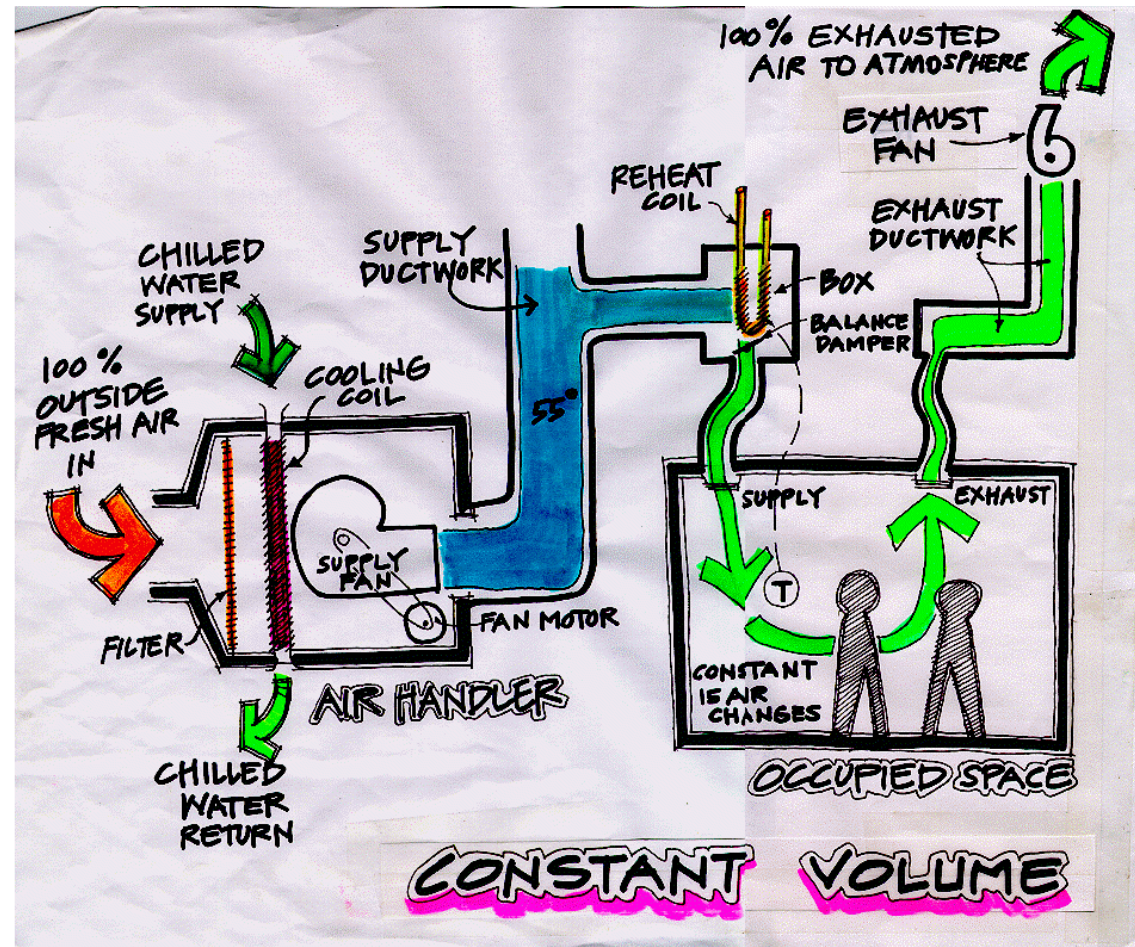


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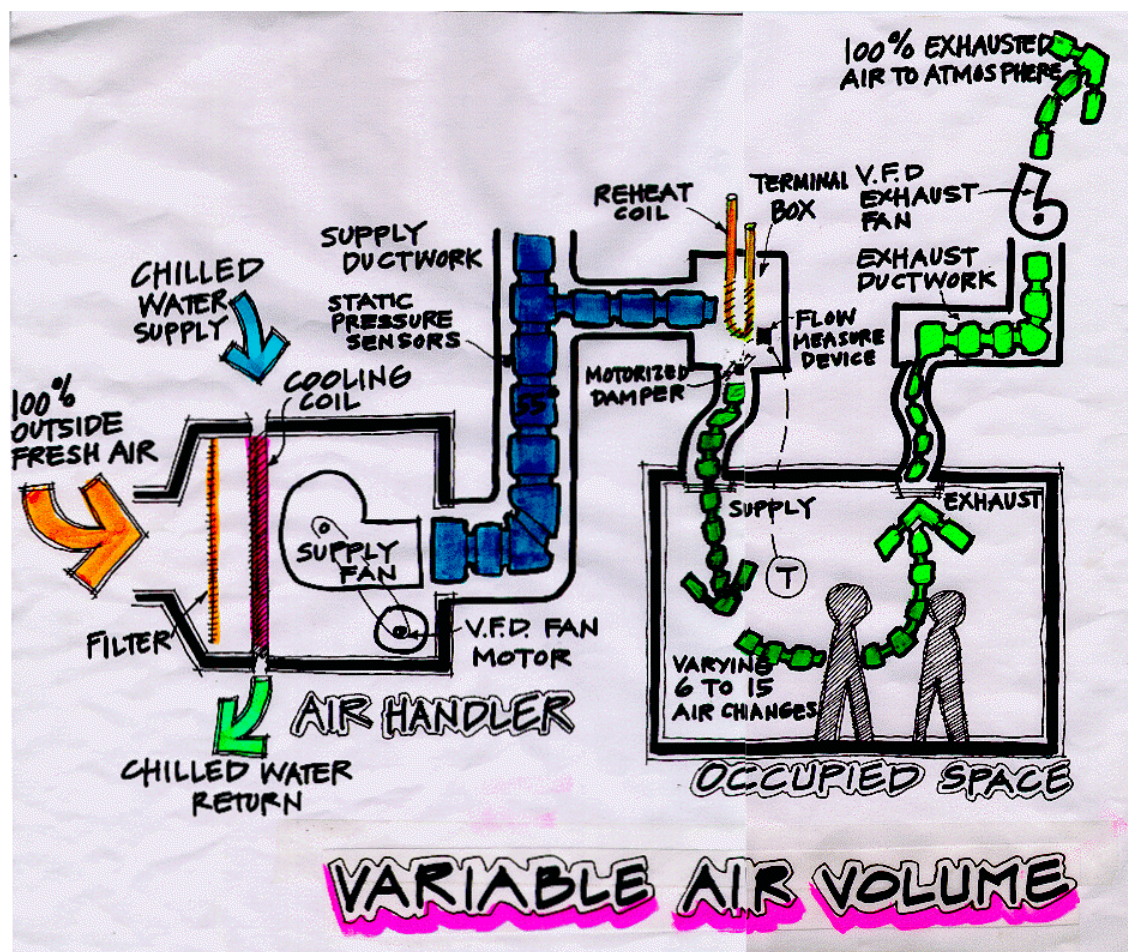
Constant Volume (CV) Systems

- u Airflow / volume is constant
- u Vary the temperature to meet demand
- o Simple reliable and safe
- o Easy to design, install, balance and maintain
- o Very energy intensive
- o Designers cannot apply diversity
- o Systems not flexible to changes



Variable Air Volume (VAV) Systems

- Airflow / volume and temperature is varied to demand
- Much more complicated and expensive controls
- Consumes 30% to 50% less energy than constant volume
- Designers can apply diversity
- System is very flexible to change



Drawing by Frank Kutlak
www.energy2001.ee.doe.gov

Fume Hoods

- **“Face Velocity”**
 - **Volume and Speed of negative pressure airflow**
 - **Typically 100 Feet per Minute (FPM) + - 20%**
 - **This can equal 800 CFM in a 4 foot hood**
- **In a facility with a high density of hoods the hood demand can be the major building system design load**



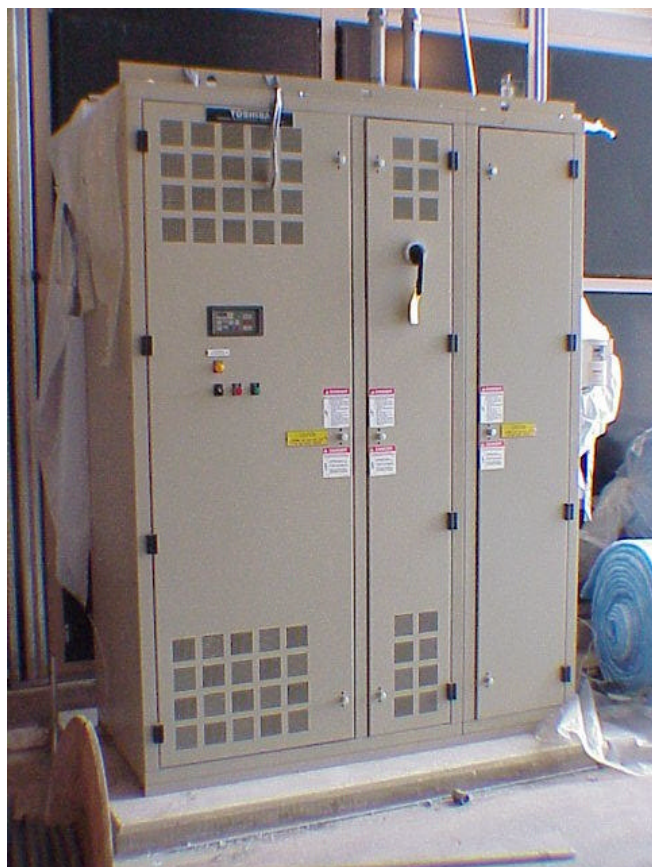


Fume Hood Comparisons

- **Conventional Hoods**
- **Auxiliary Air, Make Up Hoods**
- **By Pass Constant Volume Hoods**
- **Variable Volume Hoods**



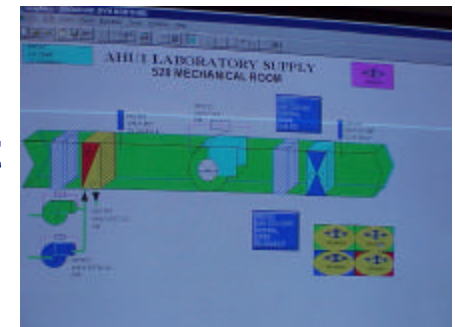
Variable Frequency Drives - VFD's





Building Controls

- DDC technology offers greater safety and energy efficiency
- A Building Automation System (BAS) provides a central computer station in the maintenance office and
 - Graphic displays of AHU's, exhaust fans, fume hoods, VAV terminal units, room temperature, room differential pressure, pumps, heat exchangers, and central utility consumption
 - Alarms and maintenance reminders are displayed automatically
- This enables the engineering maintenance staff to control, trend and monitor all of the equipment throughout the building



BAS Screen Graphic



Energy Recovery Systems

- The single most important and largest application of energy recovery in research Facilities is the heat recovery in the laboratory exhaust systems
- This can be accomplished with:
 - Plate Type- thin metallic sheets in air streams
 - Heat Pipe - horizontal tubes with liquid refrigerant in air streams
 - Run Around Coils - 2 air to liquid heat exchangers in air streams
 - Heat Wheels - heat absorbing dessicant disk rotates sequentially through and transfers energy from the exhaust and supply airstreams



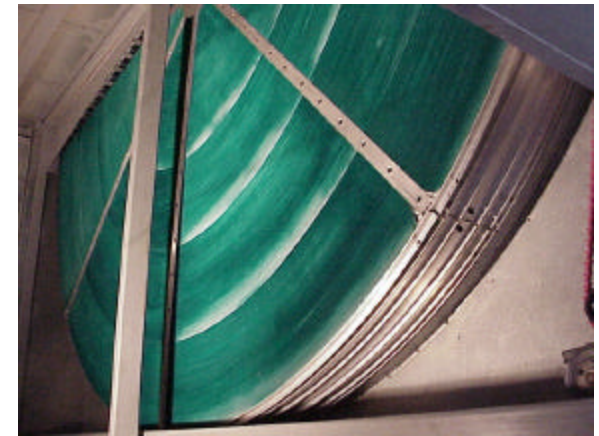
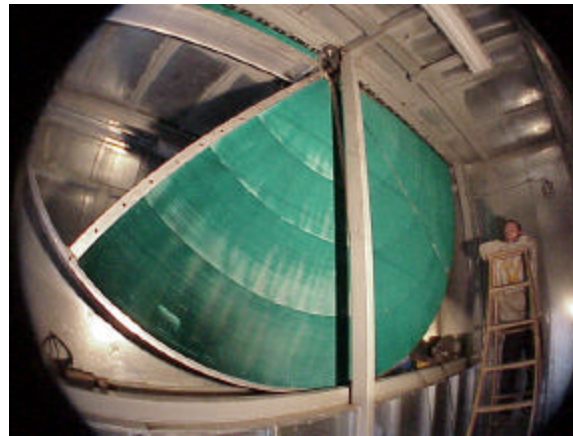
Energy Recovery Wheel Concept and HVAC System Design Issues



- **Concerns about possible cross contamination**
- **Confidence to downsize base design capacity to benefit from Energy Recovery savings**
- **Additional construction costs required to accommodate wheels**
- **Pay back periods**



Building 50 Dessicant Energy Recovery Wheel

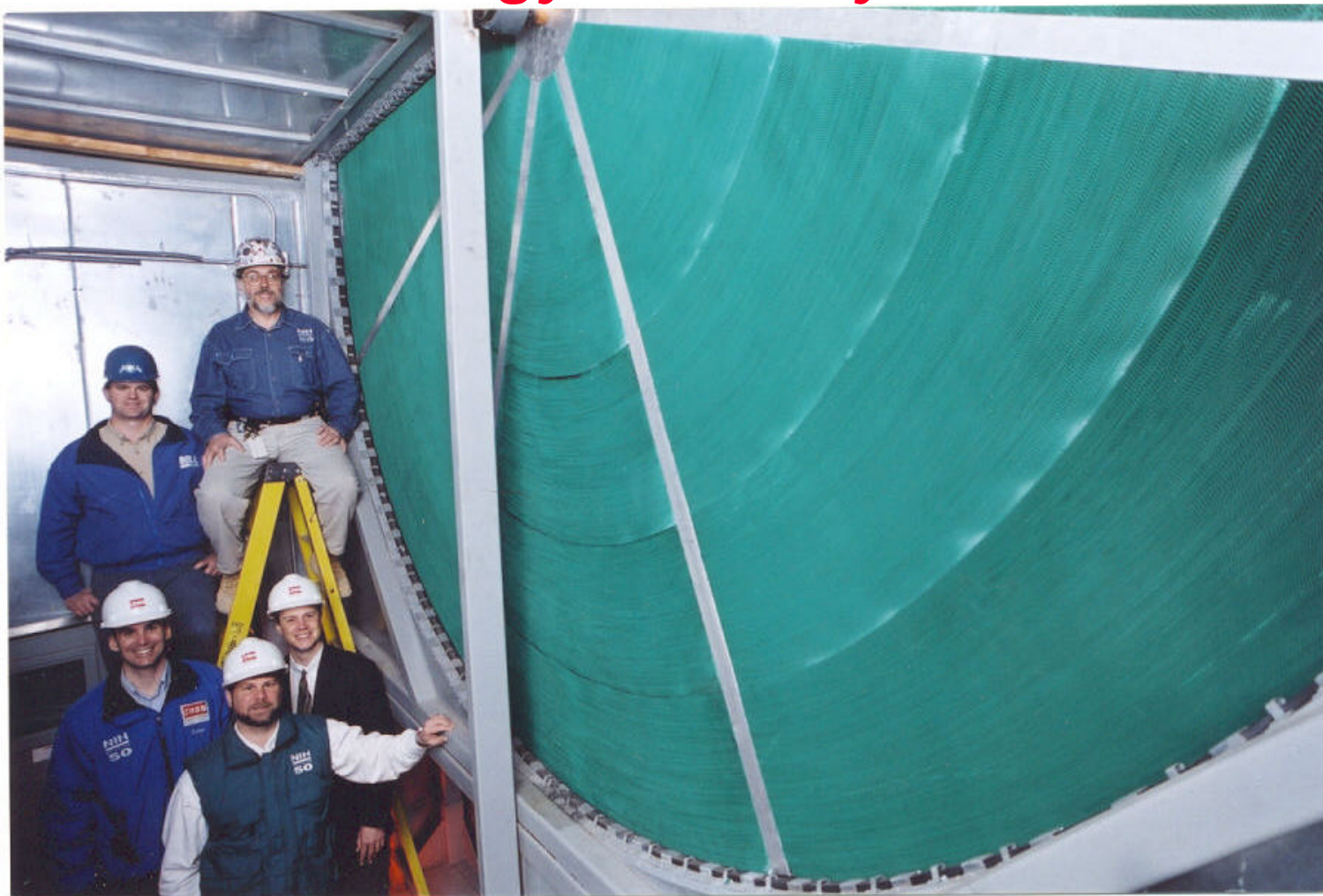


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Dessicant Energy Recovery Wheel

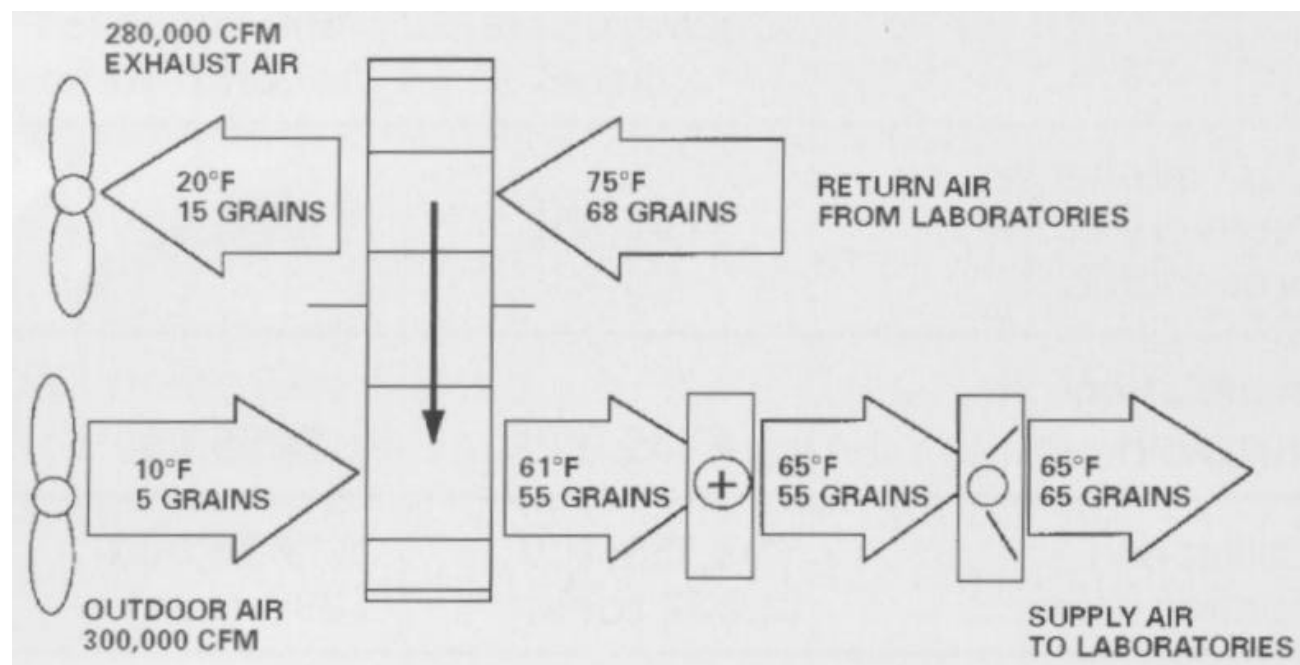


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Energy Recovery Wheel Concept - Heating

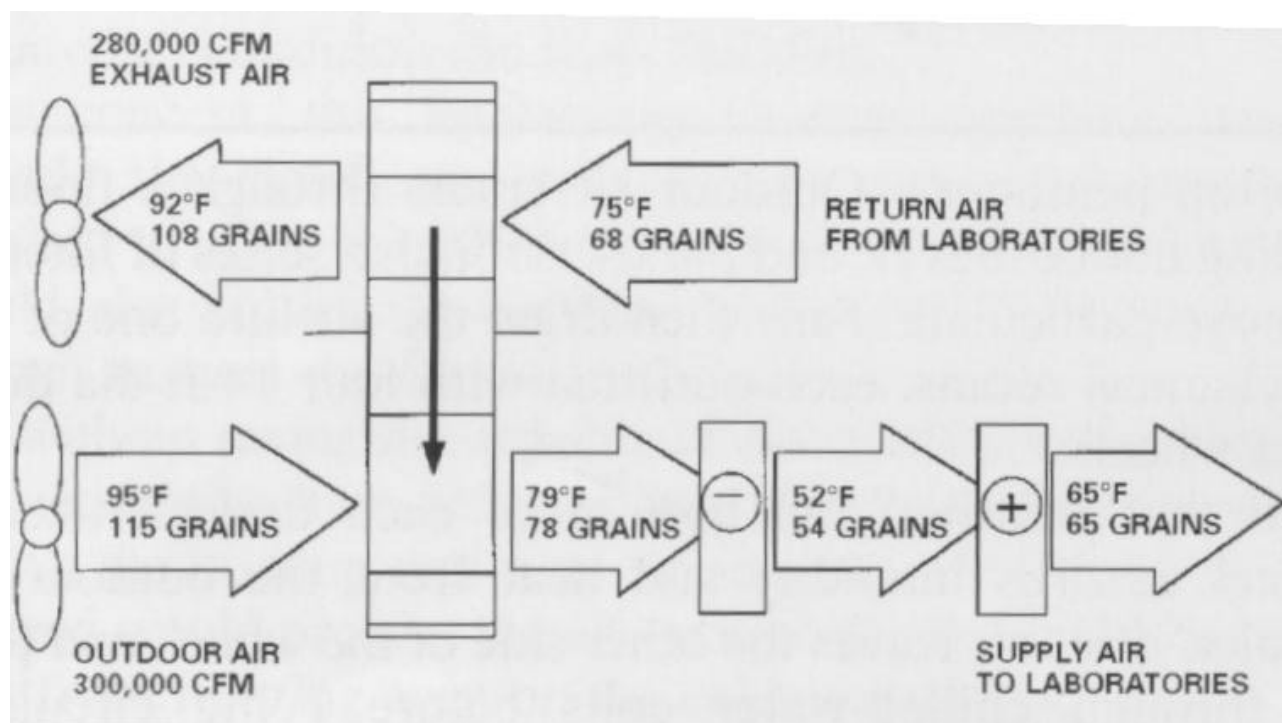
- Outgoing Warmer Air Exhaust Flow raises the temperature of the energy wheel
- which in turn then spins through and raises the temperature of the cooler incoming outdoor air



Schematic of Energy Recovery Wheel in Heating Mode_

Energy Recovery Wheel Concept - Cooling

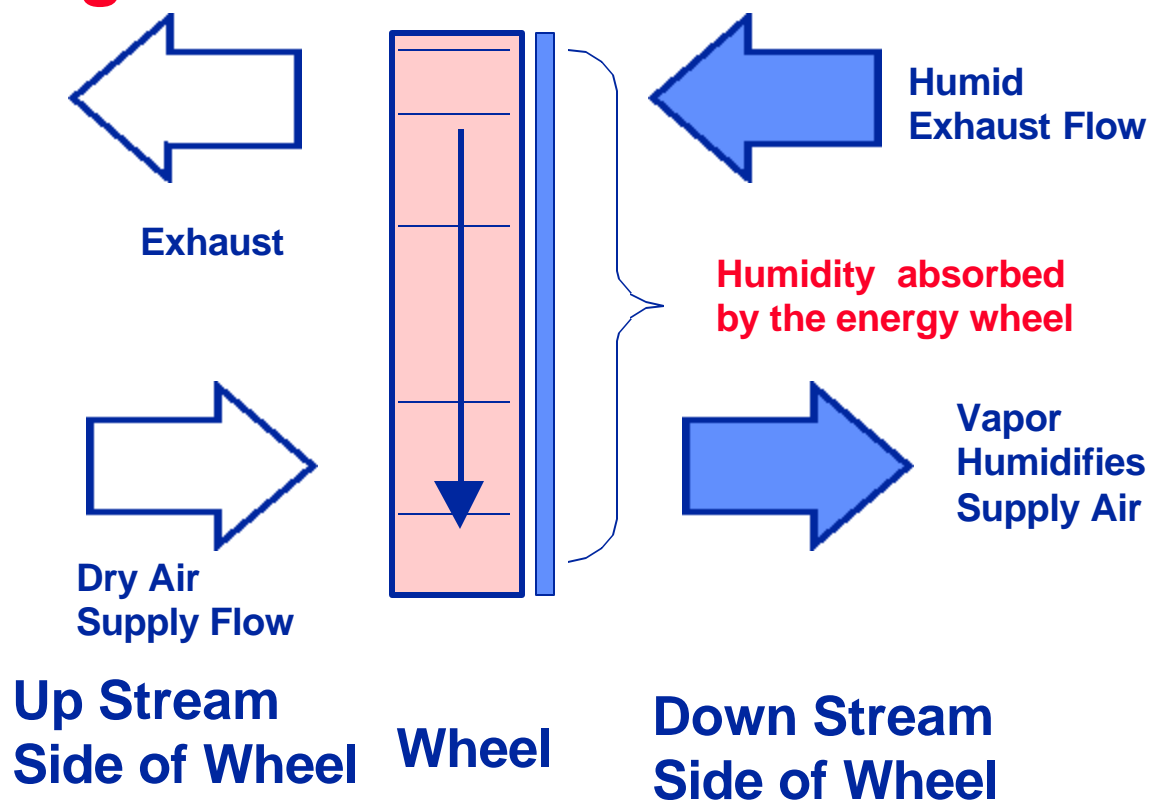
- Outgoing Cool Air Exhaust Flow lowers the temperature of the Energy Recovery wheel
- which in turn then spins through and lowers the temperature of the incoming outdoor air



Schematic of Energy Recovery Wheel in Cooling Mode

Energy Recovery Wheel Concept Humidity in Heating Mode

In the heating season the water vapor in the humid exhaust air is absorbed by the energy wheel and retained. It is then captured by and humidifies the incoming drier supply air.

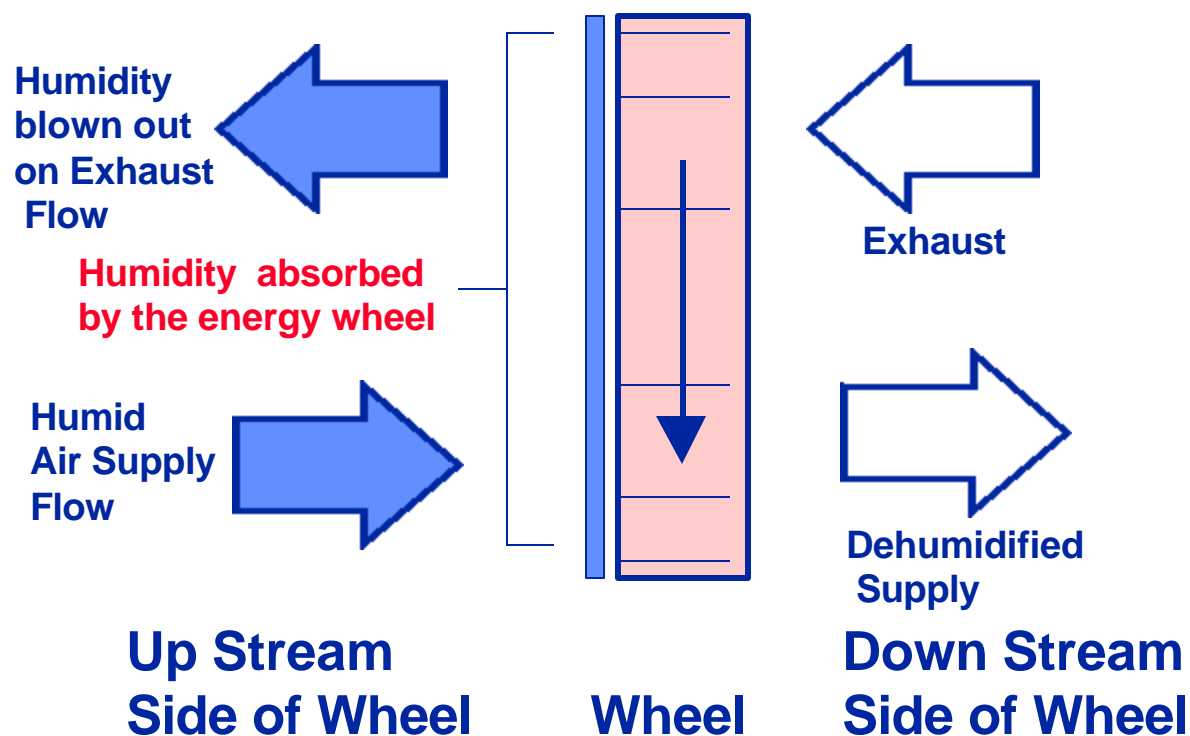


Schematic of Humidity Retention in Heating Mode



Energy Recovery Wheel Concept Humidity on Cooling Mode

In the cooling season the water vapor in the humid supply air is absorbed by the energy wheel and filtered out of the supply. It is then rejected by the exhaust flow.



Schematic of Humidity Rejection in Cooling Mode



NIH is constructing a 23 Megawatt gas fired cogeneration plant on their Bethesda MD campus. It will cut energy costs by \$55 million over 15 years and will reduce air emissions.

ENERGY USER NEWS

ENERGY MANAGEMENT FOR THE COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL MARKETS



Posted on: 11/12/2000

NIH Recognizes Importance of Running a Clean Facility

Pepco provides clean, cost-effective energy solution for rapidly growing campus

The NIH cogeneration plant will be a model for other government agencies and departments, FEMP believes.



Pepco Energy Services is providing much of the expertise required to build the facility and will operate it for 10 years under the terms of its agreement with NIH.

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In addition to the 23 MW of electricity, the unit will provide heat recovery steam generation to capture much of the energy that normally exhausts to the atmosphere. It will produce up to 180,000 pounds per hour of dry, saturated steam to the NIH steam header



NIH is using a turbine from ABB Stal, one of only 65 in the world.



NIH's steam needs in excess of the capacity of the cogeneration system will be met by NIH boilers. Additional electricity will be purchased from the local utility as needed.

You can see this entire article on the ENERGYUSERNEWS web site <http://www.energyusernews.com> search featured articles for NIH COGEN



Louis Stokes Laboratories / Building 50 Website

Address http://des.od.nih.gov/building_50

Features of the Building 50 design including floor plans, renderings, model photos, daily construction photos, hyper links to building 50 "NIH Record" articles, technical articles and a real time view of the construction site can be viewed on the Building 50 website


Office of Research Services
June 3-6, 2001



Office of Research Services - Division of Engineering Services

Building 50


The Louis Stokes Laboratories / Building 50

Welcome What's New? Schedule Contacts Daily Photos

View the "Building 50 Site" (panoramic photo):

-  [Building 50 Articles](#)
-  [Daily Photo Galleries](#)

[Click to view model renderings.](#)



Building 50 provides 250,000 GSF of state of the art laboratory, office and conference facilities.

Start Date: Jun-1997
Estimated Completion Date: Oct-2000.

DCA Project Officer: Frank Kutlak, R.A.
(301)-402-3691


Chief, Team 3: [Kristy Long](#), R.A.
Chief, DCAB: [George Williams](#), P.E.
Contracting Officer: [Barbara Taylor](#), AB-C
Bid Pkg 1 Construction Contractor:
Manhattan Construction Corp.
Bid Pkg 2 Construction Contractor:
The BELL Company.


DES After Hours Emergency Phone: 108
Off Campus Emergency Phone: (301)-496-9828


Building A Better NIH

Design:	Division of	Office of
Construction and	Engineering	Research
Alterations Branch	Services	Services

Architect: Hansen Lind Meyer Inc.	Consultants: GPR Planners Collaborative Ross Murphy Finkelstein A. Morton Thomas	Construction Manager: CRSS Constructors, Inc.	Phase II Contractor: The Bell Company
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NIH Home


ORS Home


DES Home